

Deploying GAMS Models with GAMS MIRO (Technology Workshop)

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GAMS at a Glance

Model Development and Model Deployment

GAMS MIRO Demo

Algebraic Modeling Languages (AML)



WIKIPEDIA
The Free Encyclopedia

What's that?

- High-level computer **programming languages** for the formulation of complex **mathematical optimization problems**
- **Notation similar to algebraic notation:** Concise and human readable definition of problems in the domain of optimization
- **Do not solve problems directly**, but ready-for-use links to state-of-the-art algorithms (solver)

What did this give us?

Simplified model development & maintenance

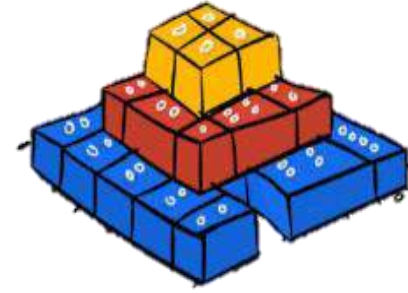
Increased productivity tremendously

Made mathematical optimization available to a **broader audience** (domain experts)

One of the success stories of OR!

- **1976:** Initial version of an AML
- **2012:** INFORMS Impact Prize awarded to „Godfathers“ of Algebraic Modeling Languages
- **Nowadays:**
 - Established environment to build robust and fail safe systems
 - Commodity in a lot of different flavors

Foundation of GAMS

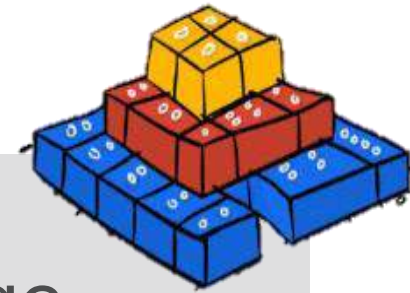


Powerful algebraic modeling language

Open architecture, independent layers

Evolved and Matured System

Declarative Language



- Similar to mathematical notation
- Easy to learn, only few basic language elements: sets, parameters, variables, equations, models

Indices:

i = plants
 j = markets

Given Data:

a_i = supply of commodity of plant i (in cases)
 b_j = demand for commodity at market j
 c_{ij} = cost per unit shipment between plant i and market j

Decision Variables:

x_{ij} = amount of commodity to ship from plant i to market j
where $x_{ij} \geq 0$, for all i, j

Constraints:

Observe supply limit at plant i : $\sum_j x_{ij} \leq a_i$ for all i (cases)
Satisfy demand at market j : $\sum_i x_{ij} \geq b_j$ for all j (cases)
Objective Function: Minimize $\sum_i \sum_j c_{ij} x_{ij}$ (\$K)

Sets

```
i  canning plants  / seattle, san-diego /  
j  markets         / new-york, chicago, topeka / ;
```

Parameters

```
a(i)  capacity of plant i in cases  
b(j)  demand at market j in cases  
c(i,j) transport cost in thousands of dollars per case ;
```

Variables

```
x(i,j) shipment quantities in cases  
z      total transportation costs in thousands of dollars ;
```

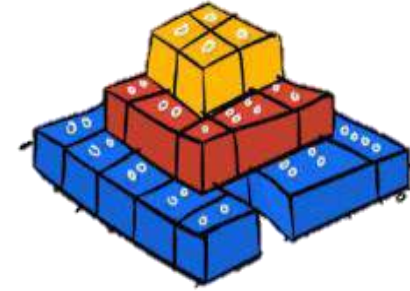
Equations

```
cost      define objective function  
supply(i) observe supply limit at plant i  
demand(j) satisfy demand at market j ;
```

```
cost ..      z  =e=  sum((i,j), c(i,j)*x(i,j)) ;  
supply(i) ..  sum(j, x(i,j))  =l=  a(i) ;  
demand(j) ..  sum(i, x(i,j))  =g=  b(j) ;
```

```
Model transport /all/ ;
```

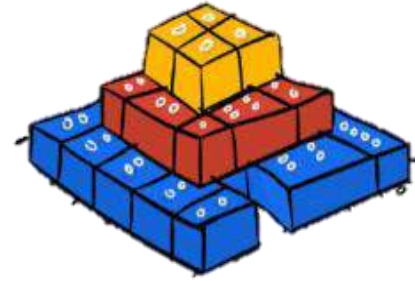
Procedural Language Elements



- Control Flow Statements (e.g. loops, for, if, macros, functions, ...)
- Build complex problem algorithms within GAMS
- Simplified interaction with other systems through OO-APIs:
 - Data exchange
 - GAMS Control

```
Welcome 6_trnsport_sovellink_seq.gms 6_trnsport_sovellink_seq.lst 7_trnsport_sovellink_async.gms 7_trnsport_s
64 Model transport /all/ ;
65
66 set s scenarios / s1*s100 /
67 sl solvelink / aSyncGrid, aSyncThreads /;
68 parameter dd(s,i,j) distance by scenario
69 time(*) time for 100 scenarios
70 sl_val(sl) solvelink value / aSyncGrid %solveLink
71 aSyncThreads %solveLink
72 scalar h(s) scenario handle;
73 scalar tmp;
74
75 dd(s,i,j) = uniform(0.9,1.1)*d(i,j);
76 option limrow=0, limcol=0, solprint=silent, lp=cplexd;
77 * Async SOLVE
78 loop(sl,
79 tmp = jnow;
80 transport.sovellink=sl_val(sl);
81
82 loop(s,
83 d(i,j) = dd(s,i,j);
84 Solve transport using lp minimizing z ;
85 h(s) = transport.handle; // save instance handle
86 );
87 repeat
88 display$readycollect(h) 'Waiting for next instance to comp
89 loop(s$hndlecollect(h(s)),
90 display$hndledelete(h(s)) 'trouble deleting handles';
91 h(s) = 0; // indicate that we have loaded the soluti
92 );
93 until card(h) = 0 or timeelapsed > 180; // wait until all m
94 time(sl) = (jnow-tmp)*24*60*60;
95 );
96 display time;
97
```


Open Architecture



Designed to interact with other systems

Model independent of

- Platform
- Solver
- Data
- User-Interface

Platform Independence

- GAMS available on all major computing platforms
- Move your models between platforms with ease



Welcome to Mac OS X



Solver Independence

Uniform interface to all major solvers

- More than 30 academic and commercial solvers connected to GAMS
- Switch between solvers with one line of code
- Documentation
- Licensing (GAMS as a „license broker“)

Documentation

Model Libraries

Search

▼ GAMS Documentation 26

▶ Release Notes

▶ Installation and Licensing

▶ Tutorials and Examples

▶ GAMS Language and Environment

▼ Solver Manuals

▶ AlphaECP

▶ AMPL

▶ ANTIGONE

▶ BARON

▶ BDMLP

▶ BENCH

▶ BONMIN and BONMINH

▶ CBC

▶ CONOPT

▶ CONOPT4

▶ CONVERT

▶ Couenne

▶ CPLEX 12

▶ Deterministic Equivalent (DE)

▶ DECIS

▶ DICOPT

▶ EXAMINER

▶ GAMSCHK

Solver Manuals

A large number of solvers for mathematical programming models have been hooked up to GAMS. The tables below provide a brief description of each solver, the model types each solver solving, and the platforms supported by each solver. For general information on using GAMS solvers, see [Solver Usage](#).

Solver	Vendor	Description
ALPHA ECP	Abo University	MINLP solver based on the extended cutting plane (ECP) method
AMPL	GAMS Development Corp	A link to solve GAMS models using solvers within the AMPL modeling system
ANTIGONE 1.1	Princeton University	Deterministic global optimization for MINLP
BARON	The Optimization Firm, LLC	Branch-And-Reduce Optimization Navigator for proven global solutions
BDMLP	GAMS Development Corp	LP and MIP solver that comes with any GAMS system
BENCH	GAMS Development Corp	A utility to facilitate benchmarking of GAMS solvers and solution verification
BONMIN 1.8	COIN-OR Foundation	COIN-OR MINLP solver implementing various branch-and-bound and outer approximation algorithms
CBC 2.9	COIN-OR Foundation	High-performance LP/MIP solver
CONOPT 3	ARKI Consulting and Development	Large scale NLP solver
CONOPT 4	ARKI Consulting and Development	Large scale NLP solver
CONVERT	GAMS Development Corp	Framework for translating models into scalar models of other languages
COUENNE 0.5	COIN-OR Foundation	Deterministic global optimization for (M)NLP
CPLEX 12.8	IBM ILOG	High-performance LP/MIP solver

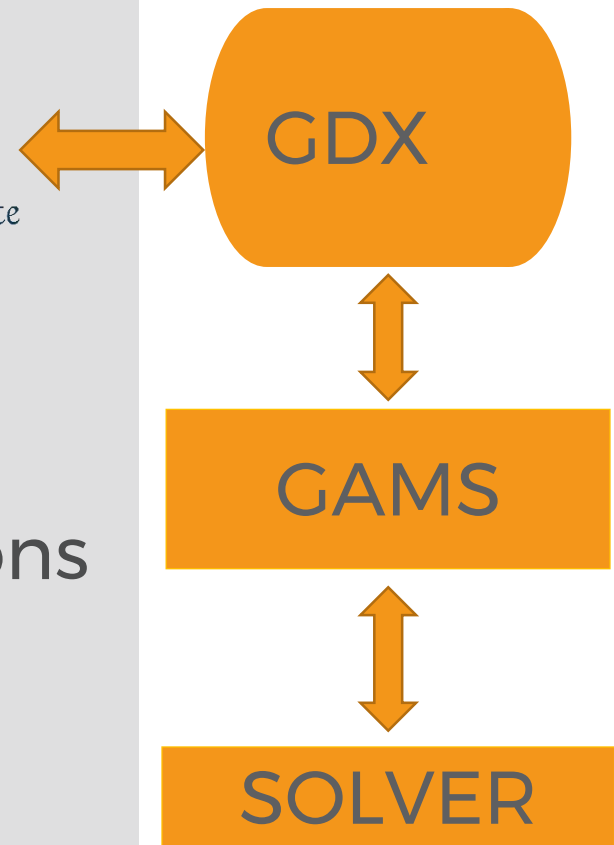
Platform / Solver Independence

(Parallel) Local and distributed/remote execution

- Solver execution
 - Remote Object Server / Compute Server
 - Distributed MIP (CPLEX, GUROBI)
 - Distributed LP (PIPS-IPM)
- Model execution
 - Grid Computing Facility
 - NEOS (Kestrel)

Data Independence

- Declarative Modeling
- Sparse Data Structures
- Scalable Models
- ASCII: Initial model
- GDX: Data layer (“contract”) between GAMS and applications
 - Platform independent
 - Direct GDX interfaces and general API’s...



User Interface Independence

No preference for a particular User Interface

- Smart Links to popular environments, like Excel, MATLAB, R, Databases, ...
- Object Oriented APIs: .Net, Java, Python, C++
- Embedded Code Facility
- Web Interface (GAMS MIRO)

Evolved and Matured System

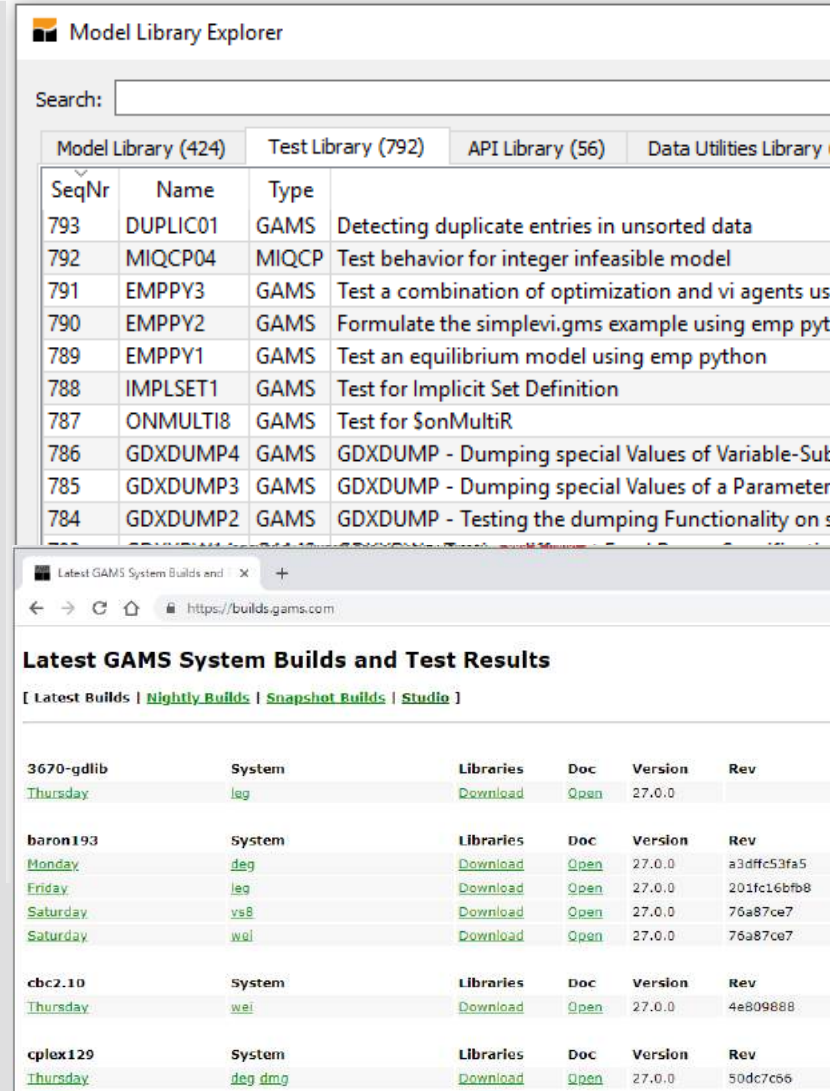


- Evolution through decades of R&D
- Maturity through experience and rigorous testing
- Lots of Development and Debugging Tools: Model Profiler, GAMSCHK, CONVERT, PAVER,...
- Quality Assurance

- 2009 GAMS available on the [Amazon Elastic](#)
- 2009 GAMS supports extended mathematical
- 2010 GAMS is awarded the [company award](#)
- 2010 [GDXMRW](#) interface between GAMS
- 2011 Support for [Extrinsic Function Libraries](#)
- 2012 The Winners of the 2012 INFORMS Im
important algebraic modeling languages [1]
- 2012 Introduction of [Object Oriented API](#) for
- 2012 The winners of the 2012 [Coin OR Cup](#)
- 2013 Support for distributed MIP (Cplex/Gur
- 2013 [Stochastic programming extension](#) o
- 2013 [GDXRRW](#) interface between GAMS
- 2014 Local search solver LocalSolver added
- 2015 LaTeX documentation from GAMS sou
- 2016 [New Management Team](#)
- 2017 [EmbeddedCode Facility](#)
- 2017 [C++ API](#)
- 2018 [GAMS Studio \(Beta\)](#)
- 2019 [GAMS MIRO - Model Interface with Ra](#)

Quality Assurance

- What are the impacts of new features, updated modules or platforms?
- Is the new distribution backward compatible?
- GAMS Test Library: ~800 quality tests
- Automatically executed every night for all solver combinations (13,000+ runs/platform)



Model Library Explorer

Search:

Model Library (424) | Test Library (792) | API Library (56) | Data Utilities Library

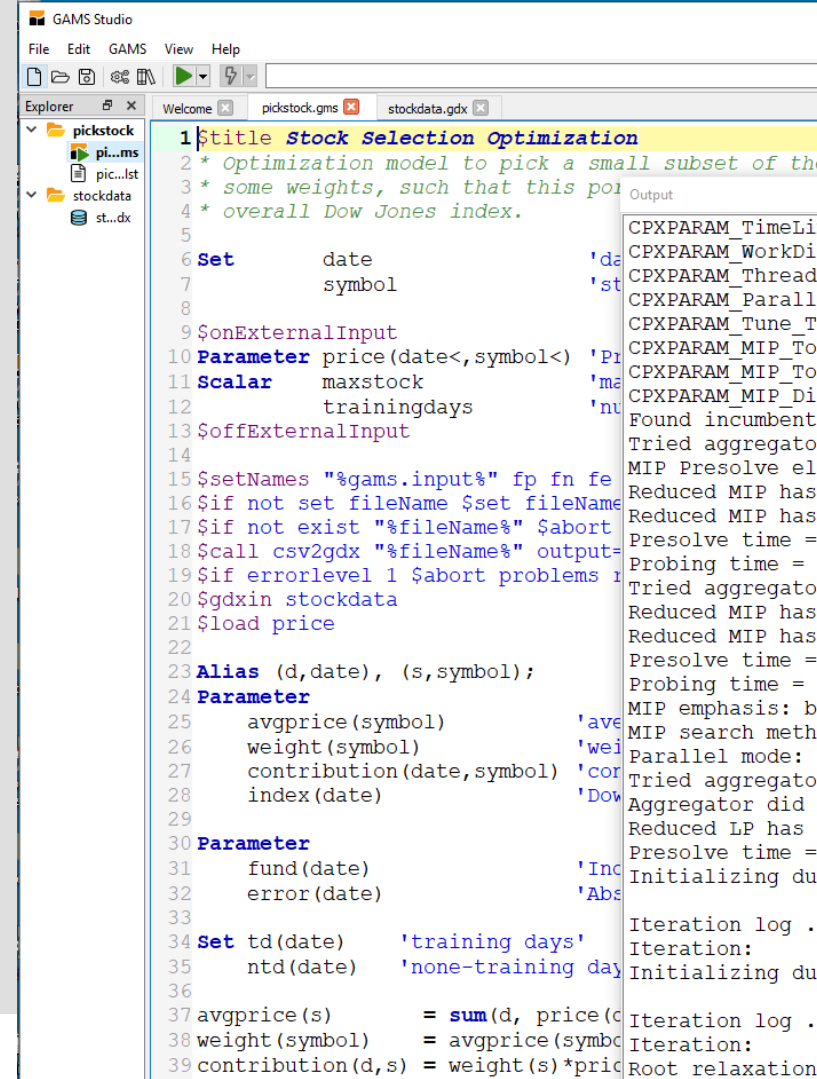
SeqNr	Name	Type	Description
793	DUPLIC01	GAMS	Detecting duplicate entries in unsorted data
792	MIQCP04	MIQCP	Test behavior for integer infeasible model
791	EMPPY3	GAMS	Test a combination of optimization and vi agents us
790	EMPPY2	GAMS	Formulate the simplevi.gms example using emp pyt
789	EMPPY1	GAMS	Test an equilibrium model using emp python
788	IMPLSET1	GAMS	Test for Implicit Set Definition
787	ONMULTI8	GAMS	Test for SonMultiR
786	GDxDUMP4	GAMS	GDxDUMP - Dumping special Values of Variable-Sub
785	GDxDUMP3	GAMS	GDxDUMP - Dumping special Values of a Parameter
784	GDxDUMP2	GAMS	GDxDUMP - Testing the dumping Functionality on s

Latest GAMS System Builds and Test Results

[Latest Builds | [Nightly Builds](#) | [Snapshot Builds](#) | [Studio](#)]

System	Libraries	Doc	Version	Rev	
3670-gdlib Thursday	leg	Download	Open	27.0.0	
baron193 Monday	deg	Download	Open	27.0.0	a3dffc53fa5
Friday	leg	Download	Open	27.0.0	201fc16bfb8
Saturday	vs8	Download	Open	27.0.0	76a87ce7
Saturday	wei	Download	Open	27.0.0	76a87ce7
cbc2.10 Thursday	wei	Download	Open	27.0.0	4e809888
cplex129 Thursday	deg dmj	Download	Open	27.0.0	50dc7c66

- Development Environment for GAMS Models
- Platform Independent (Win/Mac/Linux)
- Open source Qt project, published on GitHub (GPL)
- All features for efficient model development



The screenshot shows the GAMS Studio interface with a file explorer on the left and a code editor on the right. The file explorer shows a project named 'pickstock' with subfolders 'pickstock', 'pic...lst', 'stockdata', and 'st...dx'. The code editor displays a GAMS model named 'Stock Selection Optimization'. The model includes comments, set declarations, parameter declarations, and equations. The output window on the right shows the results of the model execution, including the title, objective function, and various solver statistics.

```

1 $title Stock Selection Optimization
2 * Optimization model to pick a small subset of the
3 * some weights, such that this portfolio
4 * overall Dow Jones index.
5
6 Set      date      'date'
7          symbol    'symbol'
8
9 $onExternalInput
10 Parameter price(date<,symbol<) 'price'
11 Scalar    maxstock 'maxstock'
12           trainingdays 'trainingdays'
13 $offExternalInput
14
15 $setNames "%gams.input%" fp fn fe
16 $if not set fileName $set fileName
17 $if not exist "%fileName%" $abort
18 $call csv2gdx "%fileName%" output=
19 $if errorlevel 1 $abort problems
20 $gdxin stockdata
21 $load price
22
23 Alias (d,date), (s,symbol);
24 Parameter
25     avgprice(symbol) 'avgprice'
26     weight(symbol) 'weight'
27     contribution(date,symbol) 'contribution'
28     index(date) 'index'
29
30 Parameter
31     fund(date) 'fund'
32     error(date) 'error'
33
34 Set td(date) 'training days'
35     ntd(date) 'none-training days'
36
37 avgprice(s) = sum(d, price(s,price));
38 weight(symbol) = avgprice(symbol,price);
39 contribution(d,s) = weight(s)*price(s,price);
  
```

Output:

```

CPXPARAM TimeLimit=1800
CPXPARAM WorkDir=
CPXPARAM Thread=
CPXPARAM Parallel=
CPXPARAM Tune=
CPXPARAM MIP Tolerance=
CPXPARAM MIP Tolerance=
CPXPARAM MIP Tolerance=
Found incumbent
Tried aggregator
MIP Presolve elapsed time=
Reduced MIP has 1000 nodes
Reduced MIP has 1000 nodes
Presolve time = 0.00
Probing time = 0.00
Tried aggregator
Reduced MIP has 1000 nodes
Reduced MIP has 1000 nodes
Presolve time = 0.00
Probing time = 0.00
MIP emphasis: basic
MIP search method =
Parallel mode:
Tried aggregator
Aggregator did not
Reduced LP has 1000 nodes
Presolve time = 0.00
Initializing dual
Iteration log .
Iteration:
Initializing dual
Iteration log .
Iteration:
Root relaxation
  
```

Uniform System Documentation



- Tutorials
- GAMS Language
- Solver
- Tools
- APIs
- Online/Offline

A screenshot of the GAMS Documentation Center website. The browser window shows a navigation bar with "Documentation" and "Model Libraries" tabs. The "Documentation" tab is active, showing a sidebar with a tree view of the documentation structure. The main content area displays the "GAMS Documentation Center" title and a description of the center's purpose. A list of links is provided, including "Release Notes", "User's Guide", "Installation and Licensing", "Tutorials and Examples", "GAMS Language and Environment", and "Solver Manuals".

Documentation Model Libraries

▼ GAMS Documentation 25.1

- ▶ Release Notes
- ▶ Installation and Licensing
- ▶ Tutorials and Examples
- ▶ GAMS Language and Environment
- ▶ Solver Manuals
- ▶ Tools Manuals
- ▶ Application Programming Interface
- Glossary
- Bibliography

GAMS Documentation Center

The GAMS Documentation Center provides a central location for maintaining our GAMS (General Algebraic Modeling System) documentation.

- **Release Notes - 25.1.1 Major release**
- **User's Guide**
 - **Installation and Licensing** - Information on the license
 - **Tutorials and Examples** - Sample models and solutions
 - **GAMS Language and Environment** - Information on the environment for executing a model
- **Solver Manuals** - Manuals of solvers

Free Model Libraries

- More than 1,600 models
- Part of any distribution
- Organized in different libraries
 - Application Specific
e.g. Finance, Energy
 - Data Connections
 - System Tests


Model Library Explorer

Search:

Model Library (424)		Test Library (792)	API Library (56)	Data Utilities Library	
SeqNr	Lic	Name	Application Area	Type	Contributor
001	G	TRANSPORT	Management Science and OR	LP	Dantzig, G B
002	G	BLEND	Management Science and OR	LP	Dantzig, G B
003	G	PRODMIX	Management Science and OR	LP	Dantzig, G B
004	D	WHOUSE	Management Science and OR	LP	Dantzig, G B
005	D	JOBT	Management Science and OR	LP	Dantzig, G B
006	L	SROUTE	Management Science and OR	LP	Dantzig, G B
007	D	DIET	Micro Economics	LP	Dantzig, G B
008	D	AIRCRAFT	Management Science and OR	LP	Dantzig, G B
009	D	PRODSCH	Management Science and OR	MIP	CDC
010	D	PDI	Management Science and OR	LP	ARCNET
011	D	UIMP	Management Science and OR	LP	Ellison, E F
012	D	MAGIC	Management Science and OR	MIP	Garver, L L
013	L	FERTS	Micro Economics	LP	Choksi, A M
014	L	FERTD	Micro Economics	MIP	Choksi, A M
015	D	MEXSS	Micro Economics	LP	Kendrick, D
016	L	MEXSD	Micro Economics	MIP	Kendrick, D
017	L	MEXLS	Micro Economics	LP	Kendrick, D
018	D	WEAPONS	Management Science and OR	NLP	Bracken, J
019	D	BID	Micro Economics	MIP	Bracken, J
020	D	PROCESS	Chemical Engineering	NLP	Bracken, J
021	D	CHEM	Chemical Engineering	NLP	Bracken, J
022	D	SHIP	Engineering	NLP	Bracken, J
023	D	LINEAR	Econometrics	DNLP	Bracken, J

Striving for Innovation and Compatibility



Models must benefit from

Advancing hardware / New Platforms

Enhanced / New solver and solution technology

New Modeling Concepts

Improved / New interfaces

Protect Investments of Users

Life time of a model: 15+ years

New maintainer, platform, solver, user interface

Backward Compatibility

Don't lock developers and users into a certain environment.

GAMS at a Glance

Model Development and Model Deployment

GAMS MIRO Demo

OR Modeler's Perspective

- Problem class
- Algorithm / Algebra
- Data
- Solver
- Solution

```

30 Parameter
31 fund(date)          'Index fund report parameter'
32 error(date)         'Absolute error';
33
34 Set td(date)         'training days'
35 ntd(date)           'non-training days';
36
37 avgprice(s)          = sum(d, price(d,s)/card(d));
38 weight(symbol)       = avgprice(symbol)/sum(s, avgprice(s));
39 contribution(d,s)    = weight(s)*price(d,s);
40 index(d)             = sum(s, contribution(d,s));
41
42 Variable
43 p(symbol)            'is stock included?'
44 w(symbol)            'what part of the portfolio'
45 slpos(date)          'positive slack'
46 slneg(date)          'negative slack'
47 obj                 'objective';
48
49 Positive variables w, slpos, slneg;
50 Binary variable p;
51
52 Equation
53 defit(date)          'fit to Dow Jones index'
54 defpick(symbol)      'can only use stock if picked'
55 defnumstock          'few stocks allowed'
56 defobj              'absolute violation (L1 norm) from index';
57
58 defit(td).. sum(s, price(td,s)*w(s)) == index(td) + slpos(td) - slneg(td);
59
60 defpick(s).. w(s) = 1- p(s);
61
62 defnumstock.. sum(s, p(s)) = 1- maxstock;
63
64 defobj.. obj == sum(td, slpos(td) + slneg(td));
65
66 Model pickStock /all/;
67
68 option cpxcr=0.01;
69
70 td(d) = ord(d)<=trainingdays;
71 ntd(d) = not td(d);
72
73 solve pickStock min obj using mip;
74
75 fund(d) = sum(s, price(d, s)*w.1(s));
76 error(d) = abs(index(d)-fund(d));
77

```

```

Output
--- Job pickstock.gms
GAMS 26.1.9 Copyr:
*** ***** B
*** GAMS for MIRO:
*** ***** B
Licensee: Irena Nel
GAMS Soft
FNElissen
--- Starting compile
--- pickstock.gms (18)
--- Call cpx2gdx 'D:\temp\stockdata.gdx ValueDim=0 1d=price
No errors, CPT2GDX time =
--- pickstock.gms (20) 3 Mb
--- GDXIn=D:\temp\stockdata.gdx
--- pickstock.gms (107) 3 Mb
--- Starting execution: elapsed 0:00:00.051
--- pickstock.gms (71) 5 Mb
--- Generating MIP model BlackStock
--- pickstock.gms (73) 5 Mb
--- 131 rows 289 columns 9,497 non-zeros
--- 30 discrete-columns
--- Executing CPLEX: elapsed 0:00:00.087

IBM ILOG CPLEX 12.8.0.0 Released Feb 02, 2019
--- GAMS/CPLEX licensed for continuous and discrete pro
Cplex 12.8.0.0

Reading data...
Starting Cplex...
Space for names approximately 0.01 Mb
Use option 'names no' to turn use of names off
CPXPARAM_Advance
CPXPARAM_Simplex_Limits_Iterations
CPXPARAM_TimeLimit
CPXPARAM_WorkDir
CPXPARAM_Threads
CPXPARAM_Parallel
CPXPARAM_Tune_TimeLimit
CPXPARAM_MIP_Tolerances_AbsMIPGap
CPXPARAM_MIP_Tolerances_MIPGap
CPXPARAM_MIP_Display
Found incumbent of value 9912.095248 after 0.00 sec. (0.05 ticks)
Tried aggregator 1 time.
MIP Presolve eliminated 1 rows and 1 columns.
Reduced MIP has 130 rows, 288 columns, and 3268 nonzeros.
Reduced MIP has 30 binaries, 0 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.07 ticks)
Probing time = 0.00 sec. (0.05 ticks)
Tried aggregator 1 time.
Reduced MIP has 130 rows, 288 columns, and 3268 nonzeros.
Reduced MIP has 30 binaries, 0 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (1.03 ticks)
Probing time = 0.00 sec. (0.09 ticks)
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: none, using 1 thread.
Tried aggregator 1 time.
Aggregator did 30 substitutions.
Reduced LP has 100 rows, 228 columns, and 3188 nonzeros.
Presolve time = 0.02 sec. (0.44 ticks)
Initializing dual steep norms . . .

Iteration log . . .
Iteration: 1 Dual objective = 0.000000
Initializing dual steep norms . . .

Iteration log . . .
Iteration: 1 Dual objective = 0.000000
Root relaxation solution time = 0.02 sec. (1.92 ticks)

Nodes
Node Left Objective IInf Best Integer Best Bound ItCnt Gap
* 0= 0 0.0000 29 9912.0952 0.0000 100.00%
Found incumbent of value 9912.095248 after 0.02 sec. (4.49 ticks)
* 0 0 0.0000 29 9912.0952 0.0000 29 100.00%
* 0+ 0 381.4598 0.0000 100.00%

```

Report

Analyze

Develop

Solve

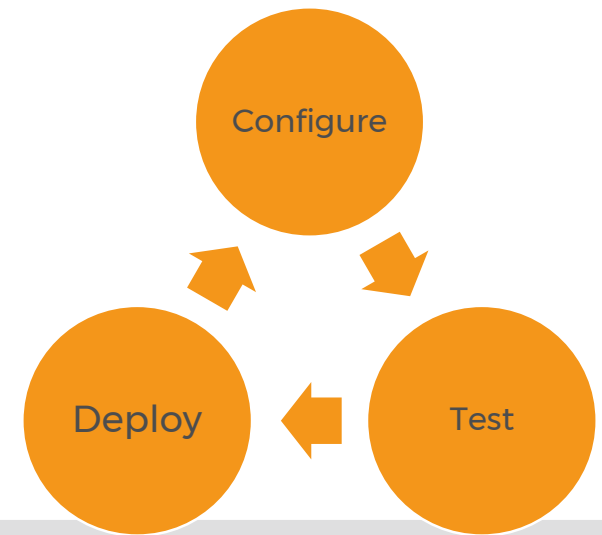
Separation of Tasks



- Use **GAMS** for modeling and optimization
- Use **Object oriented GAMS APIs** for connecting GAMS to other environments
 - ASCII (e.g. CSV)
 - Smart Links to Databases, Spreadsheets, Matlab, R,...
 - .Net, Java, Python, C++
 - Embedded Code Facility (Python)
 - Communication through Memory or Files

→ ***(Some) Programming required***

Model Deployment



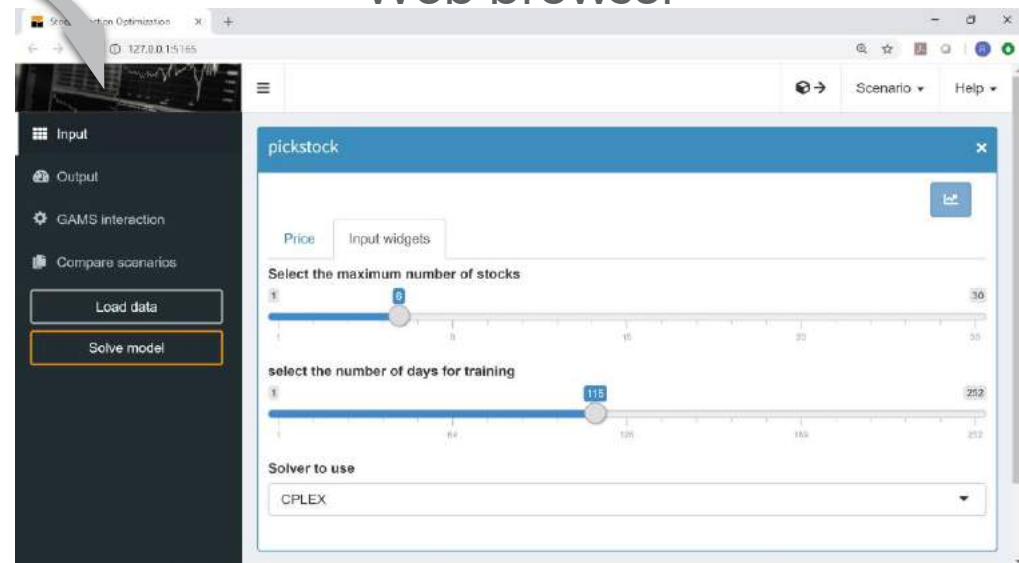
- Increasing importance for intuitive deployment and visualization
 - Need for easy-to-use tools
 - End-users are not modeling experts
- **Configuration instead of Programming**

- **Model Interface with Rapid Orchestration**
- A web interface for GAMS models
- Based on Shiny (R), open source (GPL)
- Desktop / Server Version

Click to
deploy

Web browser

Develop GAMS model

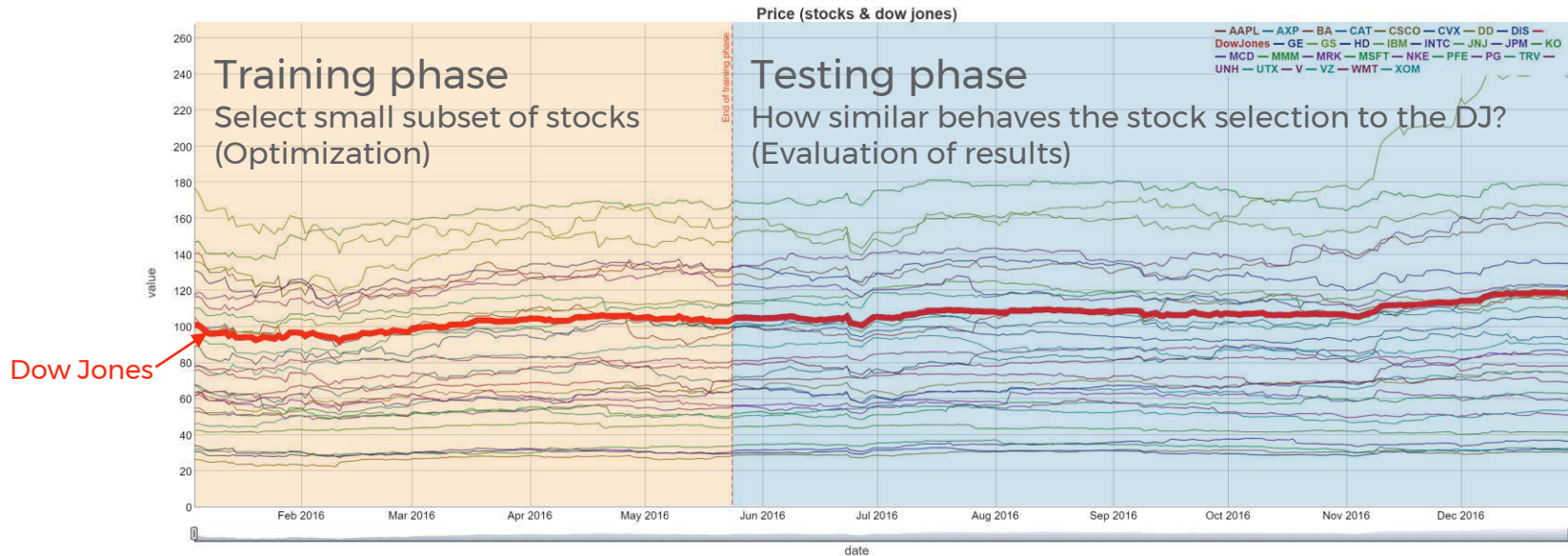


GAMS at a Glance

Model Development and Model Deployment

GAMS MIRO Demo

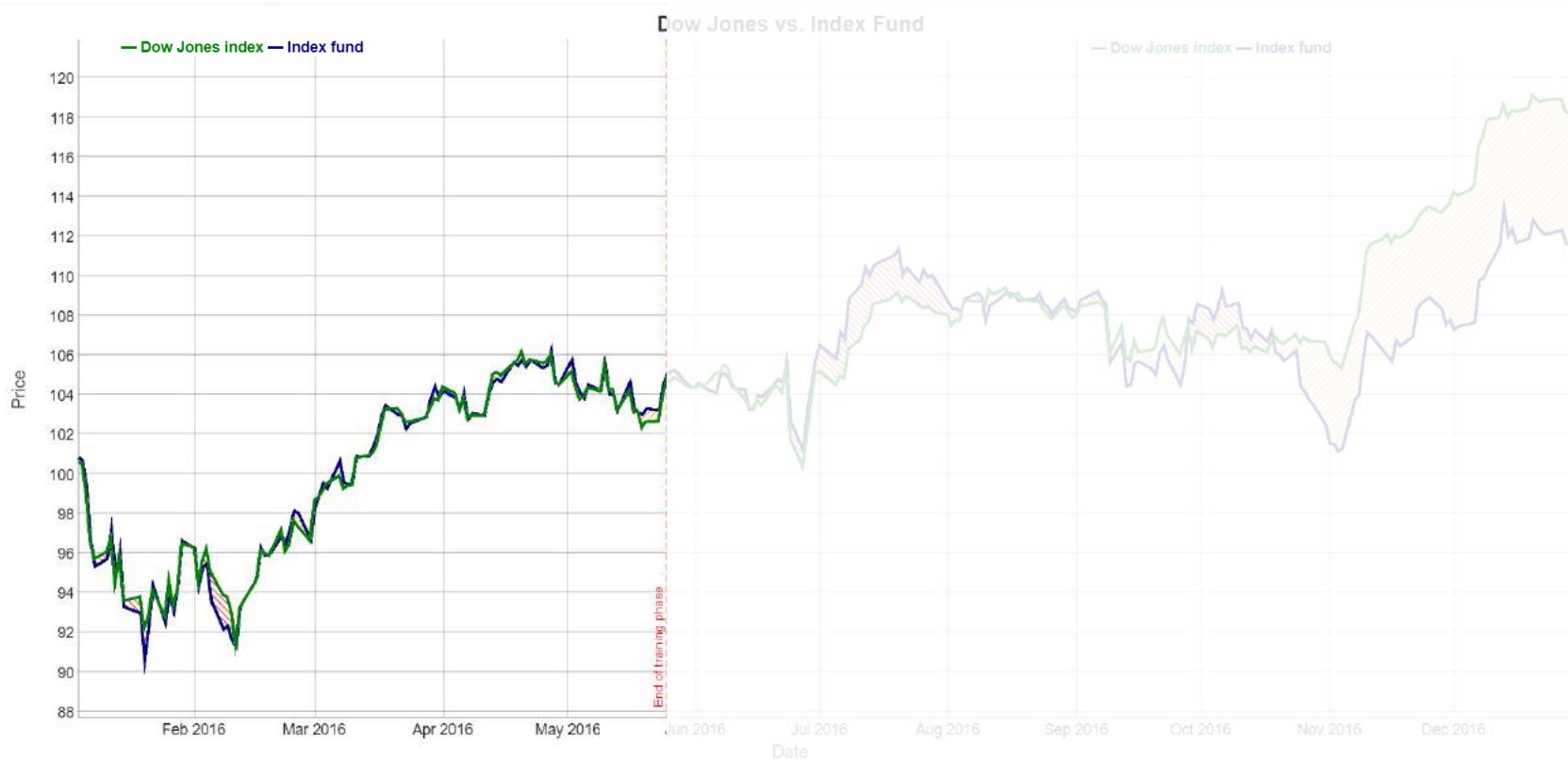
Model: *Pickstock*



- **Data:** Performance of all shares of the Dow Jones index over one year
- **Goal:** Find a small selection of stocks that follows the Dow Jones as closely as possible
- **Optimization model:** Select a subset ($\leq \text{maxstock}$) of Dow Jones stocks, along with weights, so that this portfolio behaves similarly to the overall index (in the training phase)

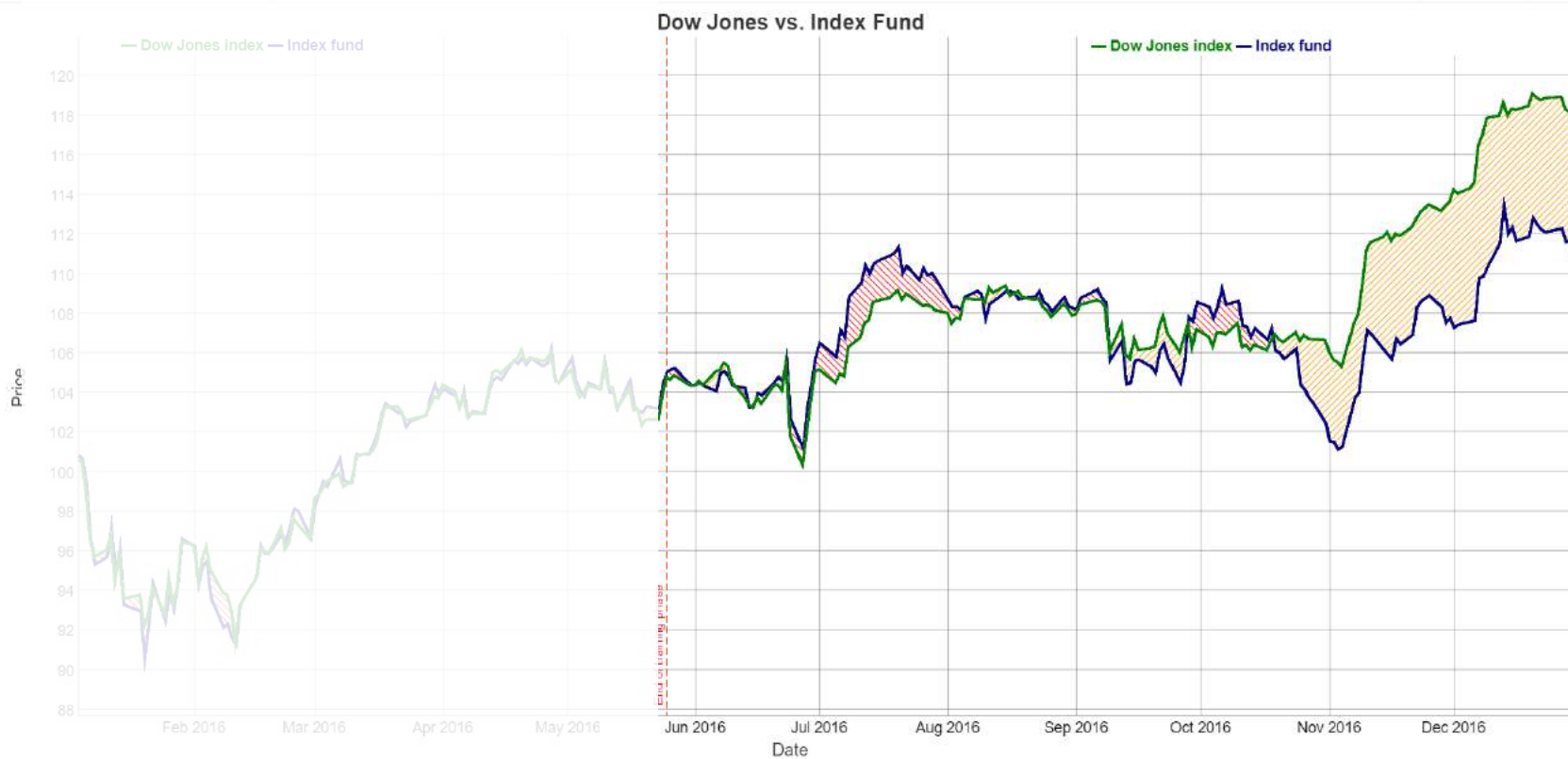
$$\begin{aligned}
 &\text{minimize} && \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds} \\
 &\text{subject to} && \sum_s \text{price}_{ds,s} \cdot w_s = \text{index}_{ds} + \text{slpos}_{ds} - \text{slneg}_{ds} \quad (\forall ds) \\
 & && w_s \leq p_s \quad (\forall s) \\
 & && \sum_s p_s \leq \text{maxstock} \\
 & && w_s \geq 0, \quad p_s \in \{0, 1\} \quad (\forall s) \\
 & && \text{slpos}_d \geq 0, \quad \text{slneg}_d \geq 0 \quad (\forall d)
 \end{aligned}$$

Model: *Pickstock*



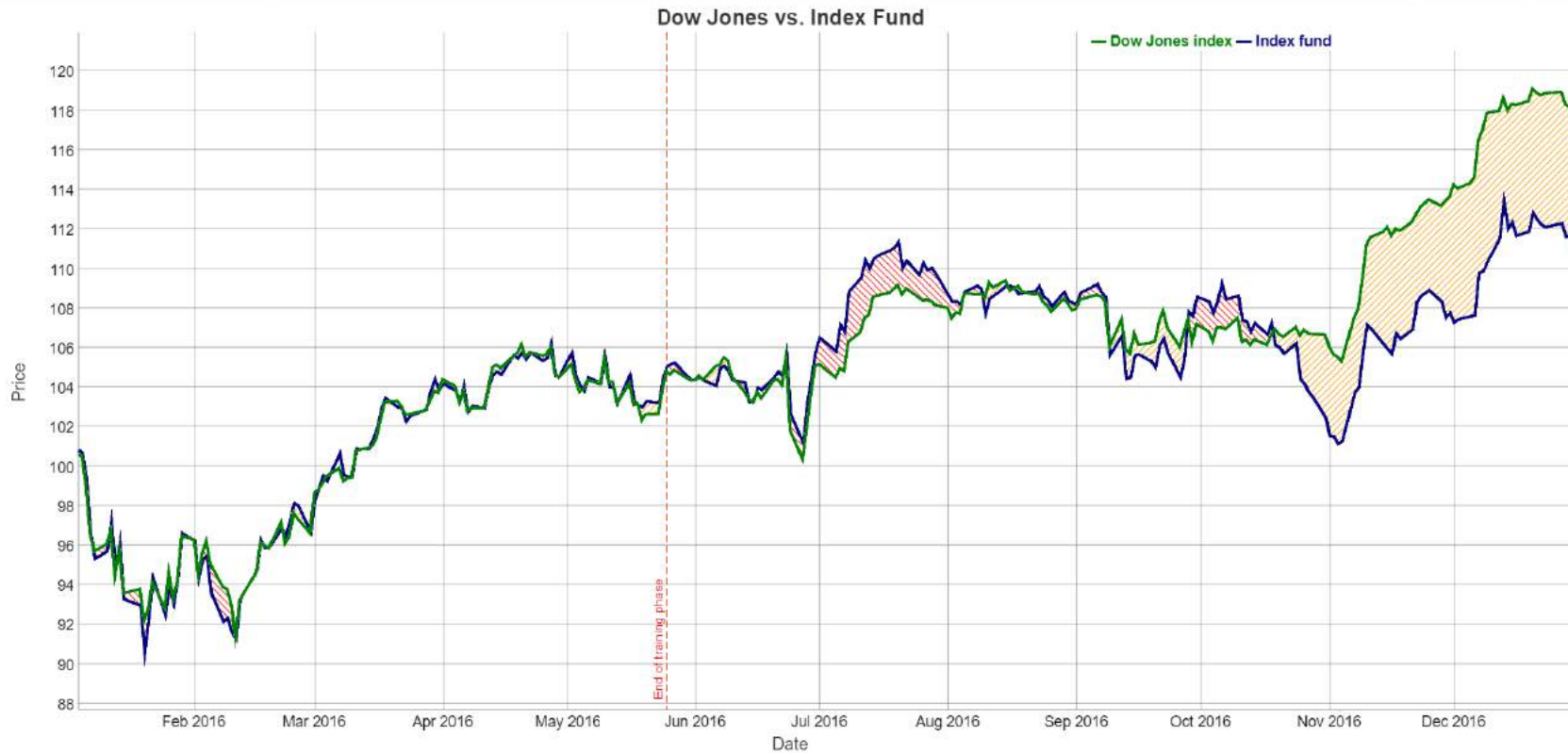
$$\text{minimize} \quad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

Model: *Pickstock*



$$\text{minimize} \quad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

Model: *Pickstock*



$$\text{minimize} \quad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

Hypercube mode scenario generation

Base mode

Hypercube mode

pickstock

Price Input widgets

Select the maximum number of stocks

1 6 30

1 8 15 23

select the number of days for training

1 115 12

1 64

Solver to use

CPLEX

pickstock

Price Input widgets

Select the maximum number of stocks

1 2 13 30

1 8 15 23 30

select the number of days for training

1 35 140 252

1 64 126 189 252

Solver to use

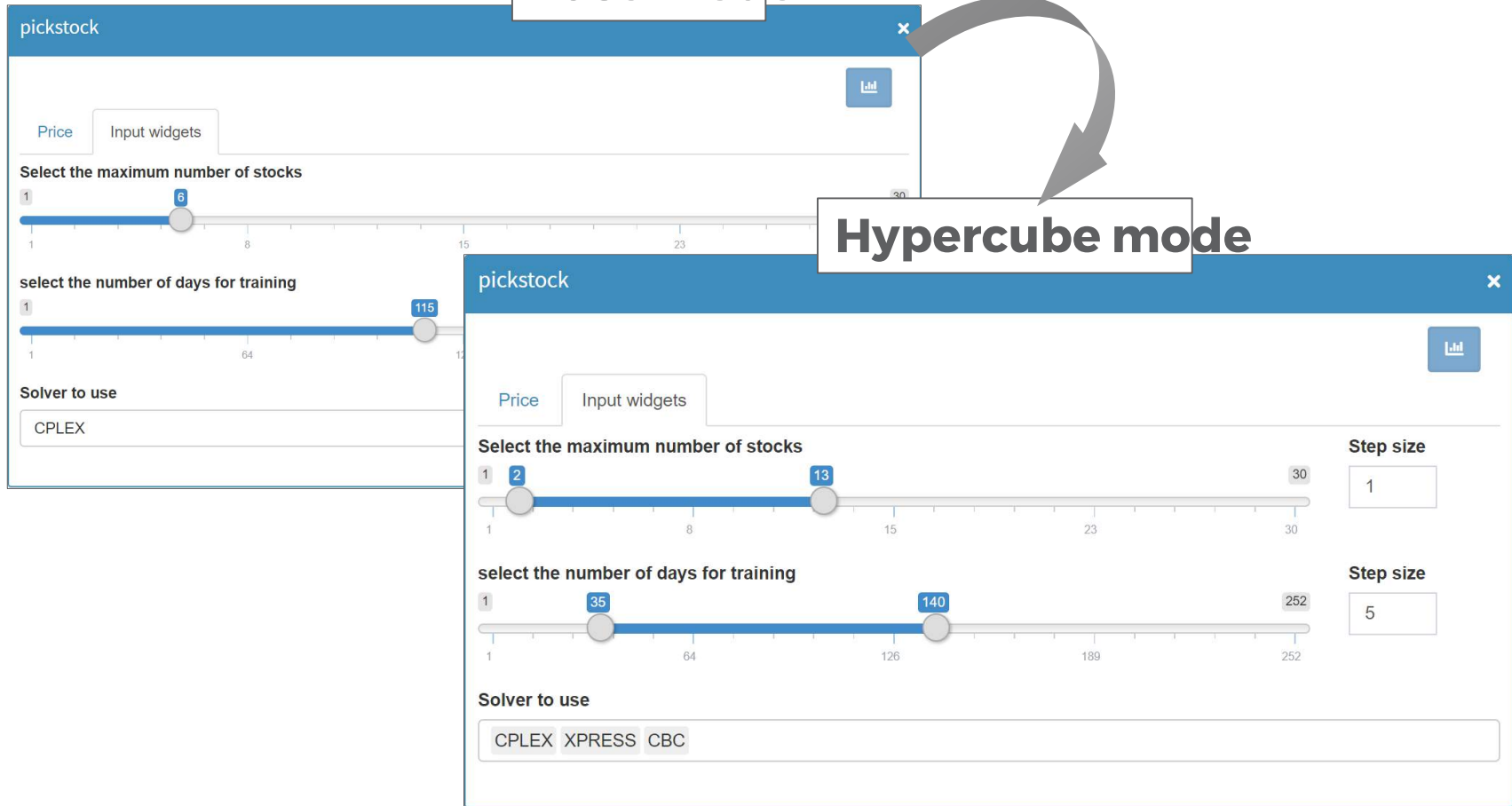
CPLEX XPRESS CBC

Step size

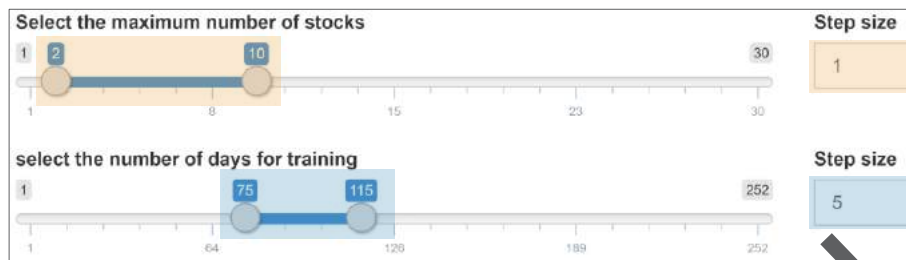
1

Step size

5



Hypercube mode scenario generation



+ 1

	2	3	4	5	6	7	8	9	10
75	1	2	3	4	5	6	7	8	9
80	10	11	12	13	14	15	16	17	18
85	19	20	21	22	23	24	25	26	27
90	28	29	30	31	32	33	34	35	36
95	37	38	39	40	41	42	43	44	45
100	46	47	48	49	50	51	52	53	54
105	55	56	57	58	59	60	61	62	63
110	64	65	66	67	68	69	70	71	72
115	73	74	75	76	77	78	79	80	81

+ 5

Number of scenarios
= Cartesian product of scalar input combinations

Scenario runs and sensitivity analysis

The GAMS MIRO Hypercube mode

Hypercube mode

Data import & monitoring of scenario runs



Import data

Owner	Submission date	Job tags	Status	Action
user	2019-01-18 15:05:09	runxy	running	Show log Discard
user	2019-01-18 15:04:53		running	Show log Discard
user	2019-01-18 15:04:42	run1	completed	Import Show log Discard
user	2019-01-18 15:02:57	all_types	completed	Import Show log Discard
user	2019-01-18 14:58:50	MIP min_ship	completed	Import Show log Discard

Show history

Manual import

Hypercube mode

Scenario management

Load scenarios

Time created

between

2019-02-01

to

2019-02-21

-

Job tags

is

superman

-

AND

Time created

between

2019-02-22

to

2019-03-04

-

Job tags

is

wonder woman

-

AND

OR

Fetch results

Show

10

entries

Search:

Owner	Time created	Job tags	maximum number of stocks to select	MIP-Solver	number of days for training	Ratio between error test and error train	Absolute error in entire testing phase	Absolute error in entire training phase	last date of training period
user	2/15/2019, 2:53:55 PM	superman	8	CPLEX	99	13.7001401311091	170.448122203935	12.4413415171496	2016-05-24
user	2/15/2019, 2:53:55 PM	superman	3	CPLEX	99	5.13673004574033	229.061239845358	44.592812510229	2016-05-24
user	2/15/2019, 2:53:55 PM	superman	24	CPLEX	99	19.3422042295776	15.0432531197135	0.777742440373459	2016-05-24

All

All

All

All

All

All

All

All

All

Showing 1 to 10 of 220 entries

Previous

1

2

3

4

5

...

22

Next

Choose selected scenarios

Choose current page

Choose all

Show hash

Analyze Scenarios

Index

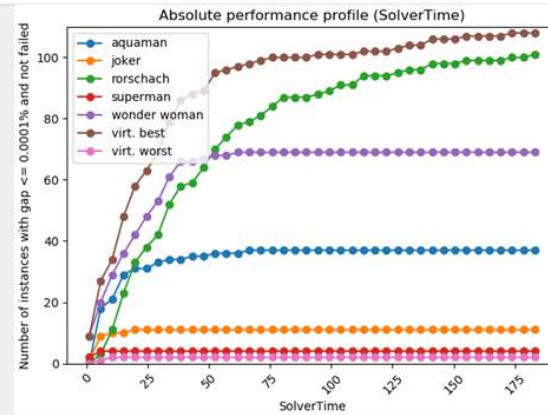
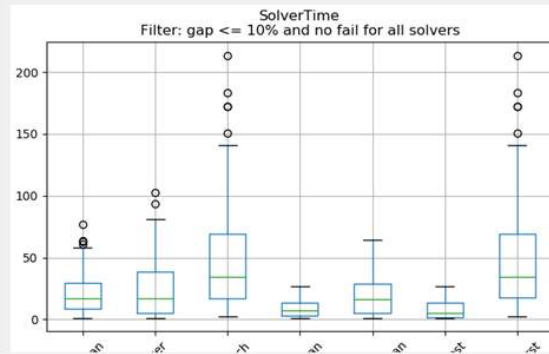
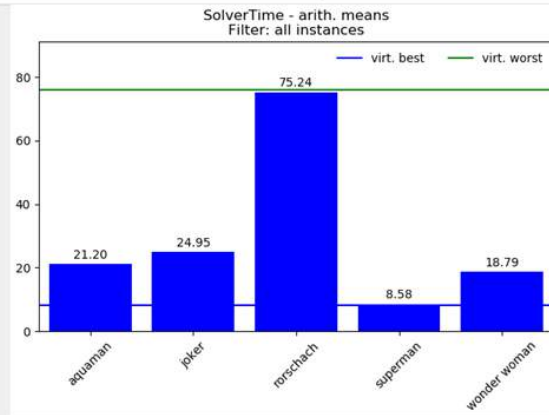
stat_Status

stat_Efficiency

stat_SolutionQuality

solvedata

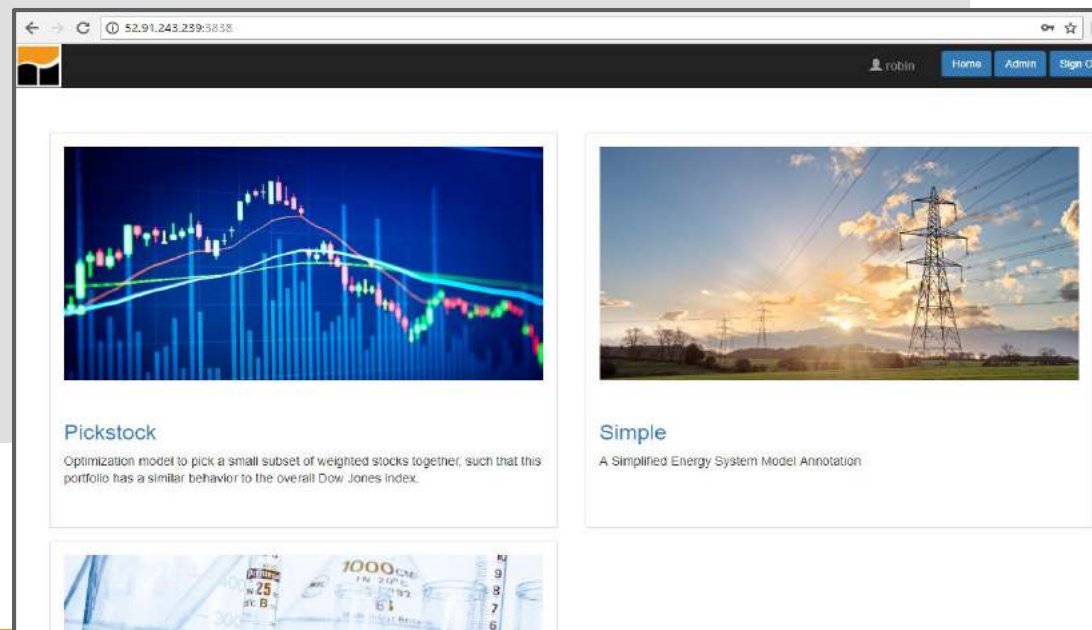
documentation



GAMS MIRO on a server



- Based on docker technology
- Authentication: LDAP, OAuth 2.0, Google,...
- Multi-user and -application management
- Load balancing
- Rolling Updates



Key points



- Quick deployment of GAMS models
- Intuitive usage without GAMS knowledge
- Easy and convenient data management
- Powerful data visualization
- Scenario Management
- Data export

Conclusions



- Desktop / Server Version
- Commercially supported
- Currently a BETA version
- Used in commercial projects
- Installer for Windows, MacOS, (and Linux)
- Configuration Generator
- Comprehensive Documentation

More Information



Documentation & Software
<https://www.gams.com/miro/>

Video
<https://youtu.be/7pUrZ-u9ZcQ>

Thank you!